Operating Instructions

Controllers
for
Vibratory Drive Systems

SCF3000

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1. Declaration of Conformity

We hereby declare that above-mentioned products are in conformity with following directives, standards and regulations:

Directive:	**Standard:**
2014/30/EU EMC	**EN 61000-6-4:2007 +A1:2011; EN 61000-6-2:2019**
2014/35/EU LVD	**EN 62477-1:2012 +A11:2014 +A1:2017**
2011/65/EU RoHS	

Rhein-Nadel-Automation

Managing Director
Dr. Tobias Hensen

For use in NFPA 79 applications only E217179

Adapters providing field wiring means are available from Rhein-Nadel Automation GmbH.
Refer to Rhein-Nadel Automation GmbH.

2. Changes / Copyright

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3. About this document

Attention
Read this document carefully and observe the safety directives before commencing any work.

Document description:
This document provides assistance in choosing your product. You will also find information on mechanical and electrical installation, operation, product extensions and accessories.
Non-observance may cause trouble with the product or the environment, reduce the product lifetime or lead to other damage.

4. Safety directives

4.1. Design of safety directives

Notice
This notice identifies useful tips for use of the controller.

Attention!
This symbol identifies hazardous situations.
Non-observance of such warnings may cause irreversible injury or even death!

4.2. Fundamental safety directives

Non-observance of the following fundamental safety measures and directives may lead to severe injury and damage to property!

Meeting the requirements given in the related documentation is a precondition for safe and trouble-free operation and for achieving the product properties specified. Further additional safety directives in the other sections must be observed as well.

4.3. Personnel

Attention!
Any work on electrical equipment of the machine/system shall be carried out exclusively by a professional electrician, or by instructed persons working under the direction and supervision of a professional electrician, according to electrotechnical rules.

Only qualified professionals are allowed to work on or with the product. IEC 60364 or CENELEC HD 384 define the qualification of these persons:

- They are familiar with set-up, installation, commissioning and operation of the product.
- They possess the qualification required for performance of their work.
- They know all regulations for the prevention of accidents, directives and laws applicable to set-up, installation and commissioning on site, and they are able to apply the same.
- They have knowledge and skills of First Aid.

4.4. Electromagnetic fields

Attention!
Inverters generate electromagnetic fields (EMF) during operation. Electromagnetic fields may interfere with active implants such as cardiac pacemakers, for example.
This represents a hazard to persons wearing active implants while they are staying in the immediate vicinity of an inverter.

4.5. Intended use

Please observe the following directives for intended use of the controllers:

- The devices described here have been designed and optimized specifically for the operation of RNA bowl feeders and linear feeders. Their use with vibratory feeders from other manufacturers is at your own risk.
- They must only be stored, fitted and operated under the conditions specified in this documentation. Please also refer to the technical data.
- Observe the limits indicated in the technical specification. Be sure in particular to verify the line current draw of the device. Please also refer to the technical data.
- These devices are not for domestic use! They are solely intended to be used as components for commercial or industrial applications.
- They do not constitute a machine as defined by 2006/42/EU: Machinery Directive.

- A machine comprising the product must not be commissioned or put into operation for the intended use until it has been declared to be in conformity with the EC Directive 2006/42/EU: Machinery Directive; Observe EN 60204−1.
- Commissioning or starting operation for the intended use is only permitted in compliance with the EMC Directive 2014/30/EU.
- Use of the product in living areas may lead to EMC disturbance. The user is responsible for taking interference suppression measures.

Attention!

- Prior to start-up make sure that the protective earth conductor is connected and in proper condition. Make the PE conductor test with approved test devices only.
- Never start up despite detected damage.
- Do not make any technical modifications to the device, except as described in this document.
- Never start up in an incompletely installed state.
- Never operate the device without the required guards in place.
- Connect, disconnect or change any electrical connections only in the absence of voltage.
- Check tightness of all connections.
- These devices are to be mounted exclusively on bases that are free from vibrations and non-inflammable.

4.6. Residual hazards

Residual hazards may remain even if all directives have been observed and protective measures taken. Such residual hazards must be considered by the user in the risk assessment of his machine/equipment. Non-observance may lead to severe injury and damage to property!

4.7. Device

Pay attention to the warning signs fitted to the device!

Symbol	Description
	**Hazardous voltage:** Prior to commencing any work on the product check for absence of voltage on all power connections.
	**Caution - leakage current:** Make fixed installation and PE connection according to EN 60204−1!

Attention

Before opening the controller, pull the mains plug and wait for the periods shown below, allowing the DC link circuit capacitors to discharge to a safe voltage level.

Discharge period: 5 minutes

4.7.1. Protection of the drive system

Certain device parameters, when set incorrectly, may cause overheating of the connected drive magnet, e.g., due to prolonged operation with an incorrect frequency setting.

4.7.2. Degree of protection - protection of persons and equipment

- All specifications relate to installed, ready-for-operation condition.
- All slots not used must be closed by protection caps or dummy plugs in order not to reduce the protection against accidental contact.

5. Product information

5.1. Characteristic features

Controllers of the SCF3000... / SCF3000M... series are variable frequency drive units specially adapted for vibratory feeder control. These devices generate a mains independent output frequency for the vibratory drive system. Fine-tuning by installing or removing leaf springs or balancing the oscillating mass is not necessary. The set vibrating frequency corresponds to the mechanical vibrating frequency of the feeder.
The devices are available as cabinet-style units with IP20 protection rating (SCF3000M…types), and as enclosed units with IP54 rating (SCF3000… types). Both versions are available as CE/UKCA-certified and CSA/UL-certified units.
The PFC circuit on the input side provides for a constant output voltage and output frequency at a line voltage between 99V and 264V and a line frequency of 50 or 60Hz. This makes the controller suitable for most power supply systems worldwide, without needing different magnets to accommodate different line voltages and line frequencies.
Also, line voltage fluctuations no longer affect the feeding speed. The supply-side PFC circuit also serves to reduce mains pollution, and to greatly increase energy efficiency thanks to the reactive power factor correction. ‘Power consumption’ is reduced by up to 45%, which translates to significantly lower operating costs.
If an optional vibration amplitude sensor is connected to the SCF3000, the controller can perform an automatic frequency search to determine the feeder’s resonance frequency. In closed-loop control mode, the output frequency of the controller is then dynamically adapted to the resonance frequency of the feeder, which changes depending on load. In this manner, the feed rate remains quasi constant irrespective of load conditions.
Please also refer to the chapter titled ‘Commissioning closed-loop control with vibration amplitude sensor’.
Both in manual and in closed-loop control mode, the feed rate is adjusted via the magnitude of the output voltage. By default, the setpoint for feed rate is specified via the internal display, but it can also come from an external source transmitting a 0(2)...10V or 0(4)...20mA DC signal.
For material flow control it is possible to connect a PNP accumulation/fill level sensor that stops the feeder when the corresponding fill level is reached.
The unit features an LC display with 4 lines of 20 characters each, and a keypad with 6 keys for operator control and parameter set-up.

Special features:

- Devices are available as cabinet-style units with IP20 rating, or enclosed units with IP54 rating
- Both versions are available as CE/UKCA-certified and CSA/UL-certified units.
- Wide input line voltage range from 99V to 264V at 50Hz or 60Hz.
- Max. output voltage independent of line input voltage: 205V (adjustable) across the entire line voltage range
- Constant feed rate even in the presence of line fluctuations
- Max. output frequency independent of line frequency: adjustable between 35Hz and 140Hz (factory-set)
- Adjustable min. and max. limits of frequency range
- Max. load current depending on device: 6A, 12A, 16A
- Minimum load current 100mA (power greater than 18VA)
- Adjustable current limit for maximum magnet current
- Closed-loop control mode, automatic resonance frequency search and correction via amplitude sensor
- Sensor amplifier for accumulation/fill level control with independently adjustable timers (On/Off delay).
- Alternatively, this sensor amplifier can also be used for changeover between high / low speeds
- In addition, a time-out function can be enabled to monitor the flow of parts (only with enclosed IP54 version)
- Relay output for status indication (ACTIVE signal)
- Relay output for ‘ready’ indication (FAULT signal) (IP54-rated enclosed version only)
- External enabling input for 24VDC or floating contact
- 24VDC output e.g. for air valve, switches with feeder (only with IP54-rated enclosed version)
- Storage of four user-specific parameter sets

- Input for thermostat (monitoring of magnet temperature)
- Optionally, cabinet-style devices can be equipped with a bus interface.
  Available types:
    - Profinet
    - Profibus
    - Ethernet/IP
    - Ethercat
    - CANBus

6. Design

The devices are available as self-contained surface-mounting units (IP54) or as IP20-rated cabinet-style units.

6.1. Enclosed version (IP54)

- Power switch
- Control and display panel
- 4-pin mains plug (without cable)
- 5-pin socket-outlet for connection of feeder.
- M12 female connector for connection of level sensor
- M12 female connector for connection of enabling signal
- M12 female connector for connection of status signal and time-out signal
- M12 female connector for connection of valve (24VDC/100mA)
- M12 female connector for connection of vibration amplitude sensor

6.2. Cabinet-style version (IP20)

- Control and display panel
- Electrical connection to external terminals
- Screw fastening on mounting plate
- Covered mounting rack for interface cards
- Tightening torque for screw terminals
  - Terminals 1-9, 31-34, 51-52: 0.22-0.25 Nm
  - Terminals 21-19, 44-46: 0.5-0.6Nm

6.3. Device variants

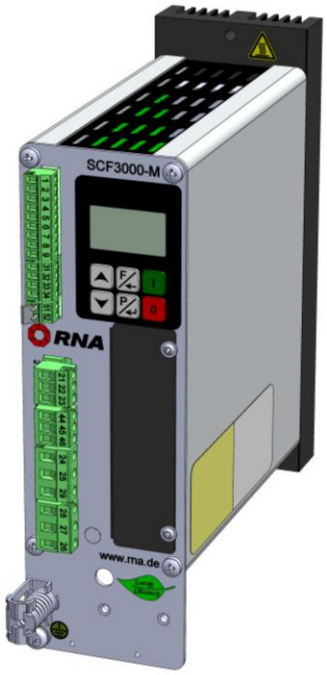
UL/CSA-certified devices are in addition identified by means of a corresponding sticker.

6.3.1. Enclosed version:

- Degree of protection IP54
- Max. current 6A
- Output for sorting air valve (24V/0.1A)
- Status relay NO contact (24V/1A)
- CE or UL

Type	RNA #
SCF3000CE 6A	31003720
SCF3000UL 6A	31003721

6.3.2. Module-style (cabinet-mounted):



- Degree of protection IP20
- Max. current 16A
- 2x status relay Changeover contact 230V/1A
- CE or UL

Type	RNA #
SCF3000MCE 6A	31003730
SCF3000MUL 6A	31003740

Type	RNA #
SCF3000MCE 16A	31003750
SCF3000MUL 16A	31003760

6.4. Technical data

Type designation	SCF3000CE 6A SCF3000UL 6A	SCF3000MCE 6A SCF3000MUL 6A	SCF3000 12A Under development *2	SCF3000MCE 16A SCF3000MUL 16A
Design	Enclosure	Module	Enclosure	Module
Degree of protection	IP54	IP20	IP54	IP20
Degree of protection	I	I	I	I
Line voltage	99V – 264V, 50/60Hz			
Power system configuration	TN system			
Max. permitted input current *1	2A	2A	4.6A	4.6A
Recommended backup protection	6A trip curve B or C		10A trip curve B or C	10A trip curve B or C
Starting current	9A, 20ms		16A, 60ms	16A, 60ms
RCD (residual-current circuit breaker)	Type B (universal)			
Output voltage	0 ... 205 V over the full line voltage range			
Load current, max.	6 A	6 A	12A	16 A
Minimum load current	100mA	100mA	100mA	100mA
Output frequency	35Hz to 140Hz factory set			
Enabling input	24VDC (10-24V) or floating contact with internal 24V			
Run-up time: **Run-down time:**	0 ... 60 sec., factory setting 1.0s 0 ... 60 sec., factory setting 0.1s			
External setpoint (analog)	0 ... 10V DC, 0(4) … 20mA			
Sensor input	1 sensor input for PNP sensor			
Sensor supply	24V DC, max. 100 mA			
Sensor delay T-ON	0 ... 60 sec. factory setting 5.0s			
Sensor delay T-OFF	0 ... 60 sec. factory setting 5.0s			
Status relay (active) *3	NO contact (24V/1A)	Changeover contact (250V/1A)	NO contact (24V/1A)	Changeover contact 250V/1A
READY relay (fault) *3	not applicable	Changeover contact (250V/1A)	not applicable	Changeover contact 250V/1A
Valve output	24VDC, 100mA, short-circuit-proof (PNP)	not applicable	24VDC, 100mA, short-circuit-proof (PNP)	not applicable
Closed-loop operation with Vibration amplitude sensor	possible			
Ambient temperature	0 ... 40 °C			
Bearing temperature	-10 … +65 °C			
Power loss	max. 55W			max. 105W
Leakage current	less than 3.5 mA			
Cooling	free convection			
Mounting	vibration-free on non-flammable surfaces			
Mounting clearances	Right/left 10mm clearance from heat sink Top/bottom 10mm clearance from heat sink			

***1Important information in chapter 'Line Current Draw'.**
Non-compliance with these instructions can lead to malfunctions and even failure.
***2Device type SCF3000 12A is still under development, technical data are preliminary.**
***3The connections of the status relay and ready relay, terminals 21-23 and terminals 44-46 must not be connected to supply systems having different potentials**

Both relay contacts must only be connected to signals from the same supply system!

6.5. Line current draw

The line current draw specified in the technical data is the maximum permissible current draw of the device. A higher current draw then specified here can lead to malfunctions and even failures.
Be advised that current draw is inversely proportional to the input voltage. When input voltage is, high input current is low, and when input voltage is low, input current is high.

Example:
A 230V vibratory feeder is operated on a 230V supply via the SFC3000. At the input of the controller a current draw of 1A is detected. Next, the same 230V vibratory feeder is operated on a 110V supply. The input voltage is only half as high as before, and consequently current draw will be twice as high. This means that the current draw of the controller will be 2A when running on a 110V supply system.

NOTICE: When planning a system, especially for international markets, make sure that, at the lowest expected line voltage, the specified maximum input current won't be exceeded.
Therefore be sure to verify the line current draw with a suitable measuring instrument.

6.6. Storage and reforming

If the unit has been in storage for a duration of one year, the internal DC link capacitors must be reformed. To to this, supply the line voltage to the SCF3000 for 60 minutes without load. For the IP54-rated version, also close the line switch. If the unit has been in storage for more than a year, reforming must imperatively be done by the manufacturer. Non-compliance with reforming instructions can lead to destruction of the device.

6.7. Connecting frequency of operating voltage

In order not to compromise the efficiency of the internal starting current damping, a waiting time of 5 seconds has to be observed after switching off the operating voltage and before switching it on again.
Therefore, starting / stopping the feeder during normal operation must always take place via the enabling input, and NOT via the mains connection.

6.8. Order designations for standard devices

Designation	Design	RNA article #
SCF3000CE 6A	Enclosed version (IP54)	31003720
SCF3000UL 6A	Enclosed version (IP54)	31003721
SCF3000CE 12A	Enclosed version (IP54)	31003722
SCF3000UL 12A	Enclosed version (IP54)	31003723
SCF3000MCE 6A	IP20-rated module-style (cabinet-mounted):	31003730
SCF3000MUL 6A	IP20-rated module-style (cabinet-mounted):	31003740
SCF3000MCE 16A	IP20-rated module-style (cabinet-mounted):	31003750
SCF3000MUL 16A	IP20-rated module-style (cabinet-mounted):	31003760
Profinet interface	for module-style devices	31003770
Profibus interface	for module-style devices	31003771
Ethernet/IP interface	for module-style devices	31003772
Ethercat interface	for module-style devices	31003773
CANBus interface	for module-style devices	31003774

UL/CSA-certified devices are in addition identified by means of a corresponding sticker.

6.9. Accessories

Identifier	Designation	Type	RNA Article #
X1	Load connector (feeder)	5-pin (EMC) Screw connection	31002329 (for 50Hz drive)
X1	Load connector (feeder)	5-pin (EMC) Screw connection	31002325 (for 100Hz drive)
X0	Mains plug 2m cable length	4-pin	31002327
X4, X5, X6, X7	Connectors for accumulation, enabling, status, solenoid valve	4-pin, M12	35051701
X4, X5, X6, X7		4-pol. M12 with 5m cable and open-ended	31003794
to X40	Amplitude sensor SW70	with 2m cable and 4-pin M12 connector, shielded	39004028
to X40	Amplitude sensor SW68	with 10m cable and 4-pin M12 connector, shielded	39905728
to X40	Amplitude sensor SW91	with 0.8m cable and 4-pin M12 connector, shielded	39980803
to module-style devices	Extension cable	for amplitude sensor, 10m, open end, shielded	39903241

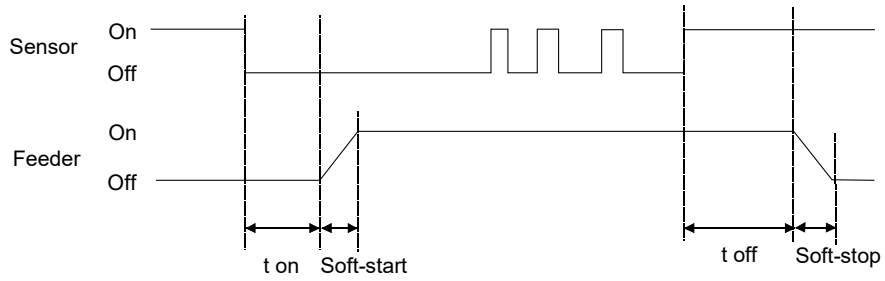
7. Function

The device is operated via a control panel on the front (with keys and LCD display). All settings can be made via menus displayed on this control panel. The various parameters are displayed in the form of plain text. In the chapter titled 'Setting Instructions' the menu function is explained in more detail. Alternatively, the feed rate can be adjusted via an external potentiometer, an external 0...10 V, DC control voltage, or 0(4)...20 mA a control current (to be selected in the menu). A floating relay contact provides a status indication when the feeder is enabled. With IP20-rated devices, the READY signal is also available as a floating relay contact.
During normal operation the LCD display indicates the feed rate setpoint in % and the vibrating frequency in Hz. A programming mode is available for adjustment of various equipment-specific values/parameters. Changed settings are permanently saved when you exit the programming mode, or after 100 seconds of keypad inactivity.
The controllers have a lower and upper frequency limit of 20Hz and 333Hz. The ratio of minimum to maximum for setting the frequency range is 1:4, i.e. the upper frequency limit may at a maximum be four times the lower frequency limit. The limits should be set tighter to ensure that the set operating frequency does not deviate too much from the system frequency. The factory setting is 35…140Hz.
Thanks to an integrated current limitation feature, the maximum output current can be adapted to the magnet.
Critical parameters such as current limit and vibrating frequency range are grouped together in special Service Parameters. These parameters cannot be accessed directly in the normal menu structure, but have to be enabled via an additional key code. This is to prevent unwanted changes to these critical parameters.

7.1. Fill level control (accumulation control)

Via internal, adjustable time steps („t on“ and „t off“) the output is switched ON or OFF dependent on the level of material measured by a sensor. The fill level swings around the position of the material sensor installed in the filling section. The output of the controller is energized when the level of the parts to be fed drops below the sensor and the set ON-delay has elapsed. If the parts to be fed exceed the position of the sensor, the output of the controller will be disabled after the OFF-delay has elapsed (display reads: ‘full’). Any gaps in the flow of parts will reset the time steps. The times are always determined by the last or first part conveyed. The ON- and OFF-delay times are set in the programming menu. The progress of the internal time steps is indicated by the clock timer shown on the display.

7.2. Sensor time-out (cycle monitoring)



This time serves to monitor the material sensor. With activation of the feeder, another time step can be started: **‘Sensor Time-Out’**. After an adjustable time period (1...240 sec.) the feeder will be switched off if no parts have passed the sensor during this time. When the feeder is turned off, the status relay is de-energized too. The display then reads ‘Track Time-Out’ and ‘Info 0001’ ‘Error’ and ‘SE’ blinking alternately. Restart the feeder to clear the alarm and restart the monitoring time.
This function is optional and has to be activated in the Accumulation Sensor menu via function ‘Time-Out ON’ = ☑.
You can use this function to monitor the material flow (supply feeder empty, parts jammed parts.
To clear the error message press the green Start key or pull up the Service menu -> Acknowledge error.

7.3. Operation with two speeds (2nd setpoint for coarse/fine switchover)

Instead of fill level control you can also use the coarse/fine function (menu ‘Accumulation Sensor’ -> Coarse/Fine). Switchover to the second setpoint takes place via the sensor input that is otherwise used for fill level control. Switchover can be activated via a contact or an external 24 V DC signal voltage. The times ‘t on’ and ‘t off’ enable you to delay the switchover. When the signal is present the system switches to ‘fine’ speed.
After activation of Coarse / Fine mode, the additional menu item ‘Fine’ appears in the speed setting menu. Here you can set the second speed.
(The fill level control function is disabled during operation with 2 speeds.)

7.4. Control inputs and outputs

7.4.1. Enabling input

External control option for switching on/off the feed rate output, e.g. for linking several devices, or for control via PLC.
The enabling signal can be provided via an external floating contactor or an external 24 VDC signal voltage.
Attention! Do not supply 24V power supply voltage

7.4.2. Sensor input for fill level control

Connection of a sensor for monitoring the material level in an accumulation section, or input for switchover to the second setpoint. (24VDC PNP switching sensor). Function is described above.
Attention! Do not supply 24V power supply voltage

7.4.3. External setpoint

The feed rate setpoint can also be specified via an external reference input variable 0(2)...10VDC, 0(4)...20mA, or a 10 kOhm potentiometer. If an external setpoint is to be used, activate the parameter 'External Setpoint' in the 'Feeder' menu.
Minimum output value for setpoint '0':
Before switching over to External Setpoint, be sure to first set the desired minimum value using the arrow keys. The set value will be applied as the minimum for setpoint '0'.
IP54-rated devices require the enclosure to be opened in order to connect the external setpoint to the internal terminals.

Attention!
Any work on electrical equipment of the machine/system shall be carried out exclusively by a professional electrician, or by instructed persons working under the direction and supervision of a professional electrician, according to electrotechnical rules.

Carefully unscrew the front module, remove a blanking plug and replace it with a suitable cable gland. Connect the external setpoint to terminals 7, 8 and 9. Screw the front module back into place. Make sure that the required protection rating (IP54) is preserved.
Terminal 7: GND, terminal 8: 0(2)…10V; 0(4)…20mA, terminal 9: +10V

7.4.4. STATUS relay control output (ACTIVE signal)

The STATUS relay picks up when the feeder is running. The relay drops out when the enabling signal is not present, or when a fault alarm is active.
250 V/1 A relay contact (changeover contact) for IP20-rated device
24V/1A relay contact (normally open) for IP54-rated device.
The status relay can be re-parameterized as a ready relay. Ready = No fault.

7.4.5. READY relay control output (IP20-rated devices only)

The READY relay picks up when the controller is turned ON and no fault alarm is present.
Relay contact 250 V/1 A (changeover contact)).

7.4.6. 24VDC/100mA Time-Out control output (IP54-rated devices only)

The output for 'Time-Out' condition is energized when the time-out function is activated and the sensor detects no material within the set time (adjustable via parameter 'Time-Out').
Attention! Do not supply 24V power supply voltage

7.4.7. 24VDC/100mA Valve control output (IP54-rated devices only)

Output for a sorting air valve.
'ON' with starting of feeder, 'OFF' with stopping of feeder. The parameters allow you to set a lead time and a stop-delay time.
Attention! Do not supply 24V power supply voltage

7.4.8. Thermostat

The frequency inverter has a special input for connection of a thermostat that can be affixed to the magnet. This provides effective protection against overheating of the feeding system.
IP54-rated devices require the enclosure to be opened in order to connect the thermostat to the internal terminals.

Attention!
Any work on electrical equipment of the machine/system shall be carried out exclusively by a professional electrician, or by instructed persons working under the direction and supervision of a professional electrician, according to electrotechnical rules.

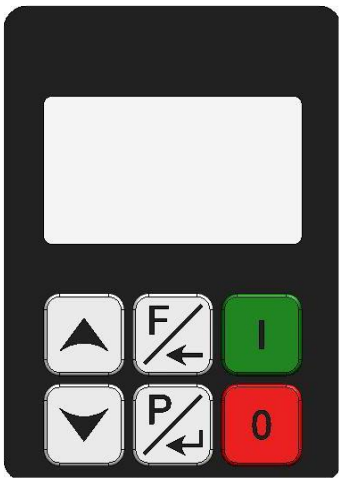
Carefully unscrew the front module, remove a blanking plug and replace it with a suitable cable gland. Connect the thermostat to terminals 51 and 52. Screw the front module back into place. Make sure that the required protection rating (IP54) is preserved.

7.4.9. Warning sign

The ‘Hot Surface Warning’ sign must be affixed in visible manner on the heat sink.

7.4.10. Display and keypad

Operation of the devices is done via the keys and the text/graphic display.



Ⓐ manual operation

Ⓐ Normal operation (with swing range sensor)

Status display

Ⓐ : 90.0 %
Frequency:50,5 Hz

Status
Feeder setpoint
Feeder frequency

Start / Reset

Stop

Function symbols

- Ⓐ Feed rate
- Feeder
- Disabled (no enabling signal)
- Material accumulation
- Maximum limitation
- Information
- Language
- Timeout

Status line symbols

- Stop-key
- „Busy“ while saving
- Key (Code) set
- Service enabled
- Line undervoltage

Key	Function for navigating menus	Function for changing values
Arrow keys	Select menu entry	Change values
F key	Return one menu level	Cancel value entry
P key	Call submenu	Apply value

8. Available settings, table of parameters

After tuning the controller to the vibratory feeder, the setting required by user is limited to the feed rate.

Feed rate adjustment:
Press the 'P' key twice, set the feed rate using the arrow keys, press the 'P' key to accept the setting, and the 'F' key to return.

To pull up the Settings menu press the 'down arrow' key once. Up comes a list with sub-items (greyed in the table below). Use the arrow keys to select the desired sub-item. Press the 'P' key to view the individual parameters.

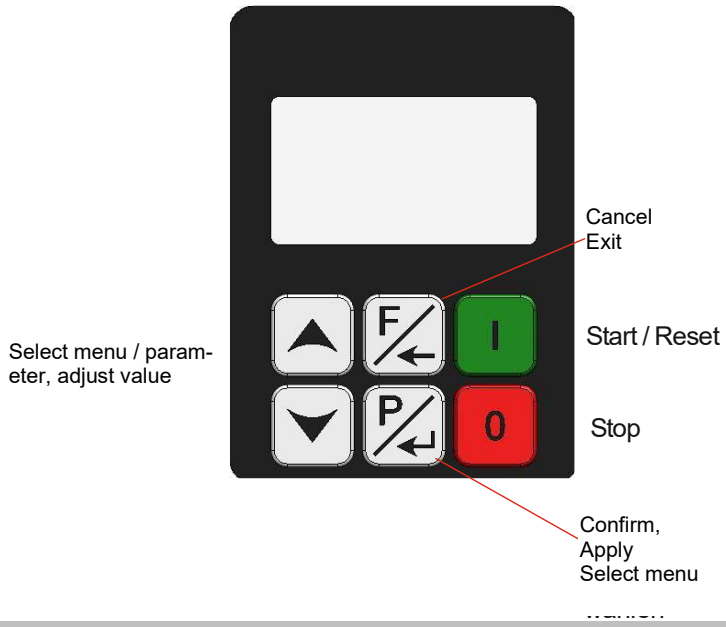
No.	Symbol	Menu item	Meaning	Einstellung	Factory setting
1	Ⓟ	**Power**			
1.1		Feeder	Feed rate	0-100%	0%
1.1.1		Fine	Setpoint for 'fine' (if 'Coarse/Fine' was activated first)	0-100%	0%
2		**Feeder**			
2.1		Frequency	Set the frequency	35-140 Hz	100 Hz
2.2		Invert.enable	Invert the enabling signal	☑ / ☐	switched off
2.3		Status-ready	Switchover status relay–ready relay	☑ / ☐	Off (statusrel.)
2.4		External setpoint	Activate external setpoint	☑ / ☐	switched off
2.4.1		Setpoint	Type of setpoint: 0/2/1-10 V / 0/4-20 mA (only if 'External Setpoint' is activated)	0/2/1-10 V / 0/4-20 mA	0-10 V
2.5		Run-up	Set the run-up time (setpoint 0% to 100 %)	0-60 sec.	1 sec.
2.6		Run-down	Set the run-down time (setpoint 100% to 0 %)	0-60 sec.	0.1 sec.
2.7		Max.	Limit maximum output voltage (delivery rate)	0-100%	90%
2.8		ACC.controller	Activate the ACC controller (turning this off deactivates Auto.Freq.)	☑ / ☐	switched off
2.8.1		Prp.Gain	Set P component of ACC controller (only if ACC controller is activated)	0.01-100	0.40
2.8.2		Integral	Set I component of ACC controller (only if ACC controller is activated)	0.01-100 sec.	0.15 sec.
2.8.3		Auto.Freq.	Activate the frequency search and correction feature (only if ACC controller is activated)	☑ / ☐	switched off
2.9		Air Jet present*[1]	Activate sorting air feature	☑ / ☐	switched off
2.9.1		Air lead time*[1]	Sorting air lead time (only if sorting air is activated)	0-60 sec.	0 sec.
2.9.2		Air delay time*[1]	Sorting air stop-delay time (only if sorting air is activated)	0-60 sec.	4 sec.
3.0		Hopper Cycled	Feeder output is cycled start-stop	☑ / ☐	switched off
3.0.1		ON time	ON time (hopper cycled mode) (only if hopper cycled mode is activated)	0-60 sec.	15 sec.
3.0.2		OFF time	OFF time (hopper cycled mode) (only if hopper cycled mode is activated)	0-60 sec.	4 sec.
3		**Accumulation sensor**			
3.1		Coarse / Fine	Coarse / Fine	☑ / ☐	switched off
3.2		T-on	ON delay	0-60 sec.	5 sec.
3.3		T-off	OFF delay	0-60 sec.	5 sec.
3.4		Time-Out On	Activate sensor time-out	☑ / ☐	switched off
3.5		Time-Out	Set time-out duration	1-240 sec.	180 sec.
3.6		Inv.Sensor	Invert the sensor	☑ / ☐	switched off

No.	Symbol	Menu item	Meaning	Setting	Factory setting
4	100	**Limit values**			
4.1		Actual current	Indication of actual current	Display only, no editing	
4.2		Limit current *3	Limit current	5-100%	100%
4.3		El. Sicherung*3	Disconnection of output instead of limitation of output current	☐ / ☐	switched off
4.4		Min.freq.*3	Set the minimum frequency	20-333 Hz	35 Hz
4.5		Max.freq.*3	Set the maximum frequency	20-333 Hz	140 Hz
4.6		UMax*3	Output voltage 230V magnet -> Umax: 100% 115V magnet -> Umax: 50%	0-100%	100%
5		**Interface**			
5.1		Bus mode	Activate / deactivate bus mode	☐ / ☐	switched off *4
5.2		Bus address	Internal bus address (do NOT change)	1…16	1
5.3		Bit rate	Internal bit rate address (do NOT change)	1Mbit/s / 500kbit/s	1Mbit/s
5.4		Protocol	Interface protocol (do NOT change)	V1.i / V2.f	V1.i
6	ⓘ	**Info**			
6.1			Software version		
7	🔧	**Service**			
7.1		Acknowledge error	Acknowledge error	execute	
7.2		Factory settings *5	Load the factory settings	execute	
7.3		Parameter set	Select a parameter set	1 / 2 / 3 / 4	
7.4		Save parameters	Save current parameters in selected parameter set (only if key code 143 is activated)		
7.5		Load parameter set	Load and apply the selected parameter set	execute	
7.6	🏳	Language	Select language	DE, EN,	EN
7.7		Key	Enter key code 127	117 / 127 / 137 / 143	
7.8		Backlighting	Backlighting: Permanent ON / OFF / Time-Out	On/Off / 0-999 sec.	
7.9		Display inverted	Invert the display colours	☐ / ☐	switched off

*1available with the enclosed version only
*3These menu items are displayed only when key code 127 is activated.
*4Depending4depending on device type
*5Check parameter ‘UMax’ after loading the factory settings.

Key code 117: Unhides the ‘Locking’ item. This enables you to hide/unhide various menus.
Key code 137: Unhides the ‘Disable’ item. This disables changing of the speed.
Key code 127: Unhides the ‘Service ON’ item. This unhides additional items in the Service menu.
Key code 143: Unhides the ‘Save Parameters’ item.

9. Operator controls



9.1. Setting behaviour

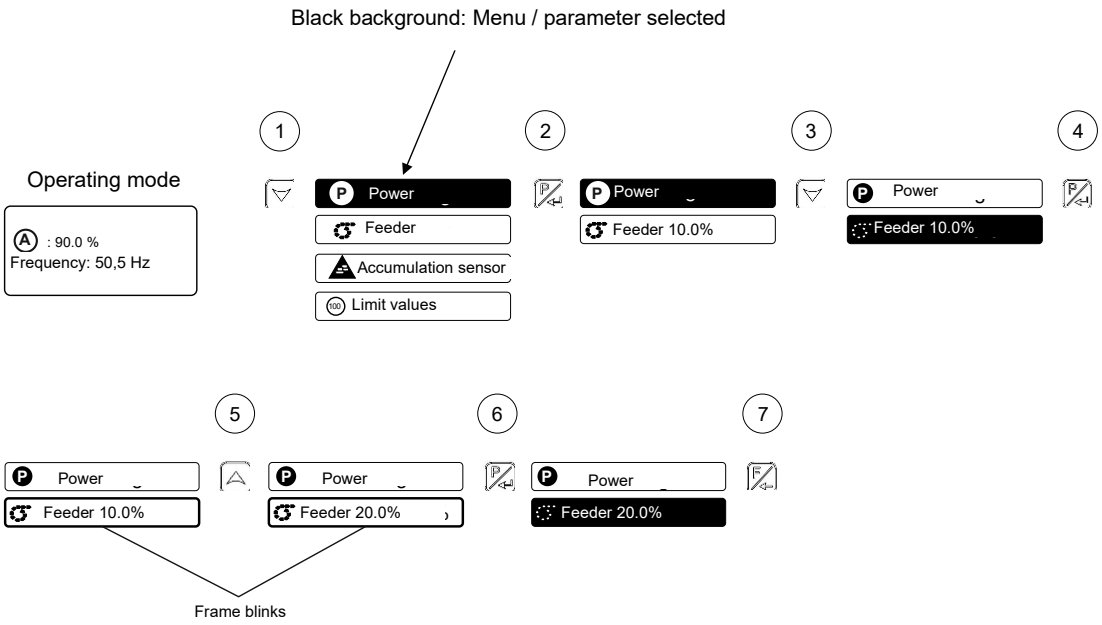
Start in Home screen

1. Jump from Home screen to menu
2. Go to desired meinu item
3. Select menu and open sub-menu
4. Select parameter
5. Activate parameter entry (editing mode)
6. Change parameter / adjust value
7. Exit parameter entry, the new value is saved
8. Back to previous menu

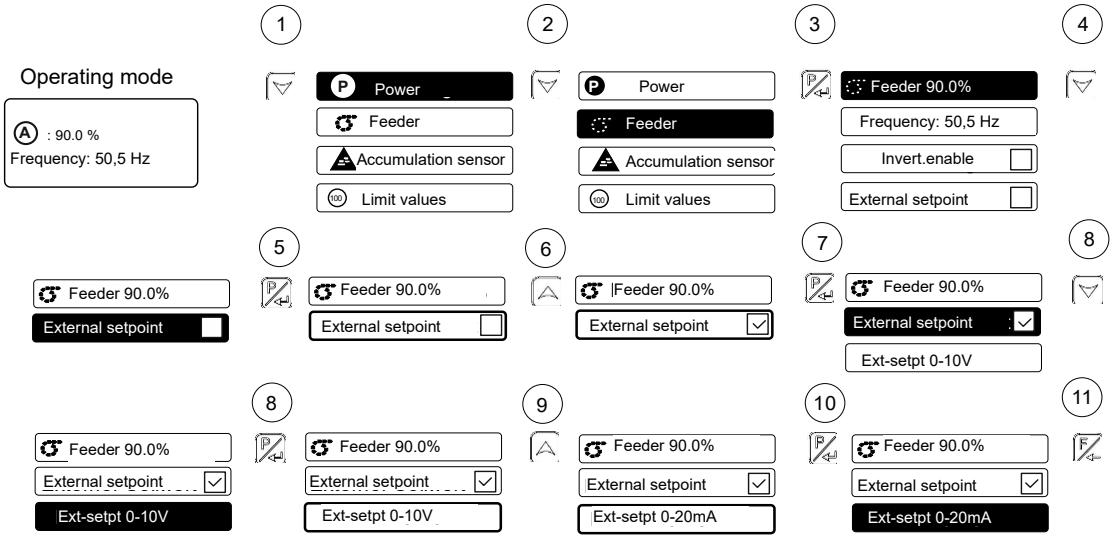
Use shortcut menu
Start in Home screen

1. Go to the shortcut menu (to parameter Setpoint)
2. Activate parameter entry (editing mode)
3. Adjust parameter (setpoint)
4. Exit parameter entry
5. Back to Home screen

9.2. Example: Setting the speed



9.3. Example: External setpoint



10. Commissioning

10.1. Place of installation

Attention!
Take care to install the devices on a non-flammable surface which is as vibration-free as possible. Be sure that there is sufficient air circulation.

10.2. Preparatory measures

- Check whether the local line voltage matches the device voltage (indication on the rating plate) and whether the connection value of the feeder is within the admissible voltage range.
- Connect controller in accordance with enclosed connection diagram.
- For applications that require switching the feeder frequently on and off, you must use the enabling input of the controller. By disconnecting the mains circuit or the load current circuit with a contactor or a switch, the device may be damaged.
- Regardless of the input voltage, the inverter output voltage in as-delivered condition is 205V AC. If you use 110V AC magnets you must limit the output voltage via the parameter ‘UMax’, otherwise the magnet and drive resp. the vibratory feeder may be destroyed. Also, after resetting the device to its factory settings, be sure to verify the setting of parameter ‘Umax’.
- If the unit has been placed in storage for a duration of one year, the internal DC link capacitors must be reformed. To to this, supply the line voltage to the SCF3000 for 60 minutes without load. For the IP54-rated version, also close the line switch. If the unit has been in storage for more than a year, reforming must imperatively be done by the manufacturer. Non-compliance with reforming instructions can lead to destruction of the device.

10.3. Notices

The controllers described here have an option to adjust the resonance frequency of the connected feeder. As in this case, already a low setpoint setting may lead to full modulation of the feeder, be sure to proceed carefully to prevent damage to the feeder due to collisions with other items of machinery.
In practice, however, the resonance frequency range cannot be used without acceleration feedback and closed-loop control of the drive frequency. As the resonance frequency depends on such factors as loading, temperature etc. the feeder would not properly respond to load changes, and become uncontrollable. Therefore, the operating frequency must be set at a certain distance (1 to 2 Hz) from the resonance frequency. The selected frequency can lie either above the resonance frequency or below it. This resonance spacing must be determined by user as the different feeders are subject to different conditions.

Resonance frequencies: Based on the design of the spring-mass system of the feeders, the system can enter resonance on several vibrating frequencies. The additional resonance points lie on a multiple of the desired frequency. For commissioning of closed-loop operation see chapter ‘Commissioning of Closed-Loop Operation with Amplitude Sensor’.

10.3.1. Operating frequency of the magnets installed

As small frequency settings might lead to a an increase in the current flowing through the magnet, be sure to check the current in the magnetic circle with an r.m.s. instrument and monitor the magnet temperature during its first use.
Make sure that the magnets are designed for the respective operating frequency in order to avoid potential overloading of the magnets due to excessive current draw.

10.3.2. Measuring the output voltage and output current

Since the controller output is an electronic inverter with pulse width modulated switching signals, the voltage and current values cannot be measured with standard measuring instruments. R.m.s. instruments, e.g. moving-iron instruments (analog dial-type instruments), must be used to measure these values. We recommend the use of such moving-iron instruments because electronic multimetres (even with RMS) will not provide reliable readings in this case. A good choice is RNA’s measuring adapter ESZ02.
It comprises moving-iron type ammeters and voltmeters and connectors for easy looping into the cable between controller and vibratory drive.

10.4. Commissioning of manual mode (without amplitude sensor)

1. Determine the vibrating frequency of the feeder.
2. Determine the power of the feeder (max. and min. permissible current draw)

Both can be found in the operation instructions for the feeder, on its rating plate, or in the tables below.
If the controller settings are unknown, reset it to the factory settings:
Turn the controller on **without a feeder being connected**, select the menu 'Service' menu, activate the parameter 'Factory Settings', and press an arrow key to confirm. The factory settings (basic set-up) are described earlier in this manual in the table of parameters under 'Available Settings'.

Bowl feeders and linear feeders, due to their mechanical design, can only be protected against damage by operating them in a proper way.
This is why the electrical operating conditions must be adapted to the vibrating system. The following tables show the safe variable operating ranges for the complete RNA product range.

RNA feeders are fitted with differently coloured magnets and connecting cables for easy distinction between vibrating frequencies.

Magnet colour	**Cable colour Magnet connection**	**Vibrating frequency for operation with line frequency**	**Vibrating frequency with variable frequency operation**
Red	Black	50Hz	47 – 56 Hz
Black	Grey	100Hz	97 – 106 Hz

Table 1

Vibratory feeder motor type	**Max. load current [Aeff]**	**Max. air gap on magnet [mm]**	**Frequency range**	**Magnet body colour**
SRC - N 160 - 2	0.55	0.5	97…106 Hz	black
SRC - N 200 - 2	1.2	0.5	97…106 Hz	black
SRC - B 200 - 2	1.2	0.5	97…106 Hz	black
SRC - N 250 - 2	2.6	1.2	97…106 Hz	black
SRC - B 250 - 2	2.6	1.2	97…106 Hz	black
SRC - N 400 - 1	3.8	2.8	47...56 Hz	red
SRC - N 400 - 2	4.3	1.2	97…106 Hz	black
SRHL 400 - 1	5.7	2.8	47...56 Hz	red
SRHL 400 - 2	5.3	1.5	97…106 Hz	black
SRC - N 630 - 1	5	2.8	47...56 Hz	red
SRC - N800 - 1	8.5	3.0	47...56 Hz	red

Table 2

Linear feeder motor type	**Max. load current [A_{eff}]**	**Max. air gap at magnet [mm]**	**Frequency range**	**Magnet body colour**
SLL 400	0.6	1	97…106 Hz	black
SLL 800	1.4	3	47...56 Hz	red
SLL 804 <1600	1.4	3	47...56 Hz	red
SLL 804 ≥1600	2.8	3	47...56 Hz	red
SLF 1000-1000	2.8	2.5	47...56 Hz	red
SLF 1000-1500	5.6	2.5	47...56 Hz	red
GL 01	0.6	1.5	97…106 Hz	black
GL 1	0.9	1	90...120 Hz	black
SLK - N 6	1.4	2.5	47...56 Hz	red
SLK - N 6 G	1.4	2.5	47...56 Hz	red

If the excitation frequency deviates more than -3Hz / +6Hz from the oscillation frequency specified in the operating instructions (50Hz or 100Hz), springs must be installed or removed.

Attention:
Uniform weight distribution on the bowl (balancing) is a prerequisite for consistent and stable feed rates.
A well balanced spring package configuration is described in detail in the operating instructions for **vibratory feeders** and **linear feeders**.

To perform the basic set-up:

- Connect the feeder (see connection diagrams below)
- Set the frequency (50Hz or 100Hz, see feeder data). 'Feeder' menu, parameter 'Frequency"'
- Set/check the current limit (see feeder data). 'Limit Values' menu, parameter 'Limit Current' (specifies the current limit as % of maximum). If need be, unhide the parameter in the Service menu by entering key code '127', factory setting 100%.
- Turn the feeder ON by pressing the green Start key.
- Increase setpoint value, observe feeder, check for correct running.
- Set maximum setpoint and check whether power has to be limited (e.g. in case of feeder collisions with other items of machinery; make mechanical adjustments).
  If necessary, adjust the limit as follows:
- Adjust setpoint to '0'.
- In the menu 'Feeder', set parameter 'Max' (maximum limitation) to 50.
- Adjust setpoint to '100'.
- Increase maximum limit 'Max.', starting at 50%, until the maximum amplitude is reached.
- Now you can use the complete setpoint range 0...100 %.

Further settings, e.g. soft start, delay times etc. must be made specifically for each system.

Manual adjustment of the vibrating frequency
Be sure to adjust the output frequency with a low setpoint setting, as a large vibrating amplitude may occur already at a low output voltage when you hit the resonance frequency.
To determine the resonance frequency with precision, an analog pointer-type r.m.s. current meter (moving iron measuring instrument) has to be connected to the output line. Then change the frequency in small steps. **The resonance frequency is reached at maximum vibrating amplitude and minimum output current.**
To obtain stable operation of the feeder independent of load, the set operating frequency must be 1 to 2 Hz above or below the resonance frequency.
This resonance spacing must be determined by user as the different feeders are subject to different conditions.

11. Reset error messages / ERROR

Error messages

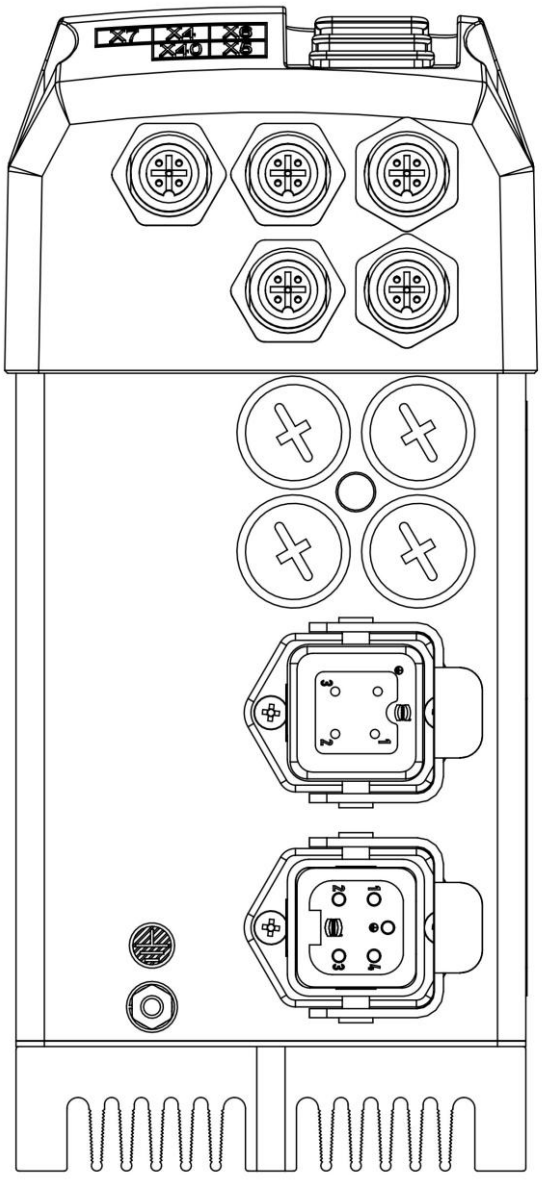
If an error is present, a message blinks in the first display line.
Error_2401/2402 ACC Sensor Error: ACC sensor not connected, or defective.
Error_0005 Overvoltage: Mains input voltage too high.
Error_0002 Overload: Output power exceeded, e.g. incorrect frequency setting, air gap too big.
Error_0088 Overcurrent: Defective magnet, ground fault, defective cable.
Error_0001 Track Time-Out : When sensor time-out function has tripped
Error_0112 Controller Overheated
Error_0113 Magnet Overheated: (signal from external thermostat)
Error_0087 Peak Current: Frequency set too low for the magnet installed, or
frequency changed too fast during set-up.
Acknowledge the message via men item Service -> Errors. Note that with most (but not all) errors, pressing the green 'I' key will already work.

Problem	Complementary information	Potential cause
Feeder is not running.	The display shows the ⛔ symbol.	The enabling signal is blocked. Check the connection and parameter settings for the enabling condition.
Feeder is not running.	The display shows the STOP symbol.	The red ‘Stop’ key been operated. Press the green key „Start / Reset“ .
Feeder is not running.	A setpoint is shown on the display.	Check for proper connection of the feeder.
ACC sensor error	Error message: ACC sensor error 2401/2402	Check for proper connection of the ACC sensor.
The frequency search won’t start.	The display indicates a fixed frequency.	AFC controller is not switched ON. Activate ‘Auto. Freq’.
The frequency search won’t start.	The vibration amplitude of the conveyor is too small.	The sensor signal is too small. Increase the setpoint value.
The frequency search won’t start.	The vibration amplitude of the feeder is too large.	The sensor signal is too large. Check the mounting location of the sensor. Check the V/g ratio of the sensor.
The frequency search stops at the ‘Min. Freq.’ limit value.		The resonance frequency is lower than the ‘Min. Freq.’ limit value. Check the setting.
The frequency search stops at the limit value for ‘Max. Freq.’		The resonance frequency is higher than the ‘Max. Freq.’ limit value. Check the setting.
The frequency search moves away from the resonance frequency.		During initial commissioning (and only then) it may happen that the inverter will at first move away from the resonance frequency. In this case, the search will reverse at the frequency limits and move back towards the resonance frequency.

12. Connecting controllers

12.1. Connection and locations of connectors and terminals

Enclosed version (IP54, 6A)
External connections



X7 24V output to valve
1 = +24 VDC output
3 = GND

X4 Fill level sensor
1 = +24 VDC
2 = nc
3 = GND
4 = +24 VDC input

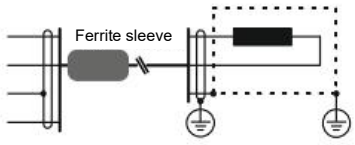
X40 Amplitude sensor
1 = +24 VDC
2 = Input
3 = GND
4 = nc

X6 Enabling input
1 = +24 VDC
2 = nc
3 = GND
4 = +24 VDC input

X5 Status output
1 =
2 = nc
3 = GND
4 =
5 = Timeout +24V output
Relay contact (max. 24V, 1A)

X0 Line connection
110/230 V,
50/60 Hz
1 = L
2 = N
3 = nc
4 = PE

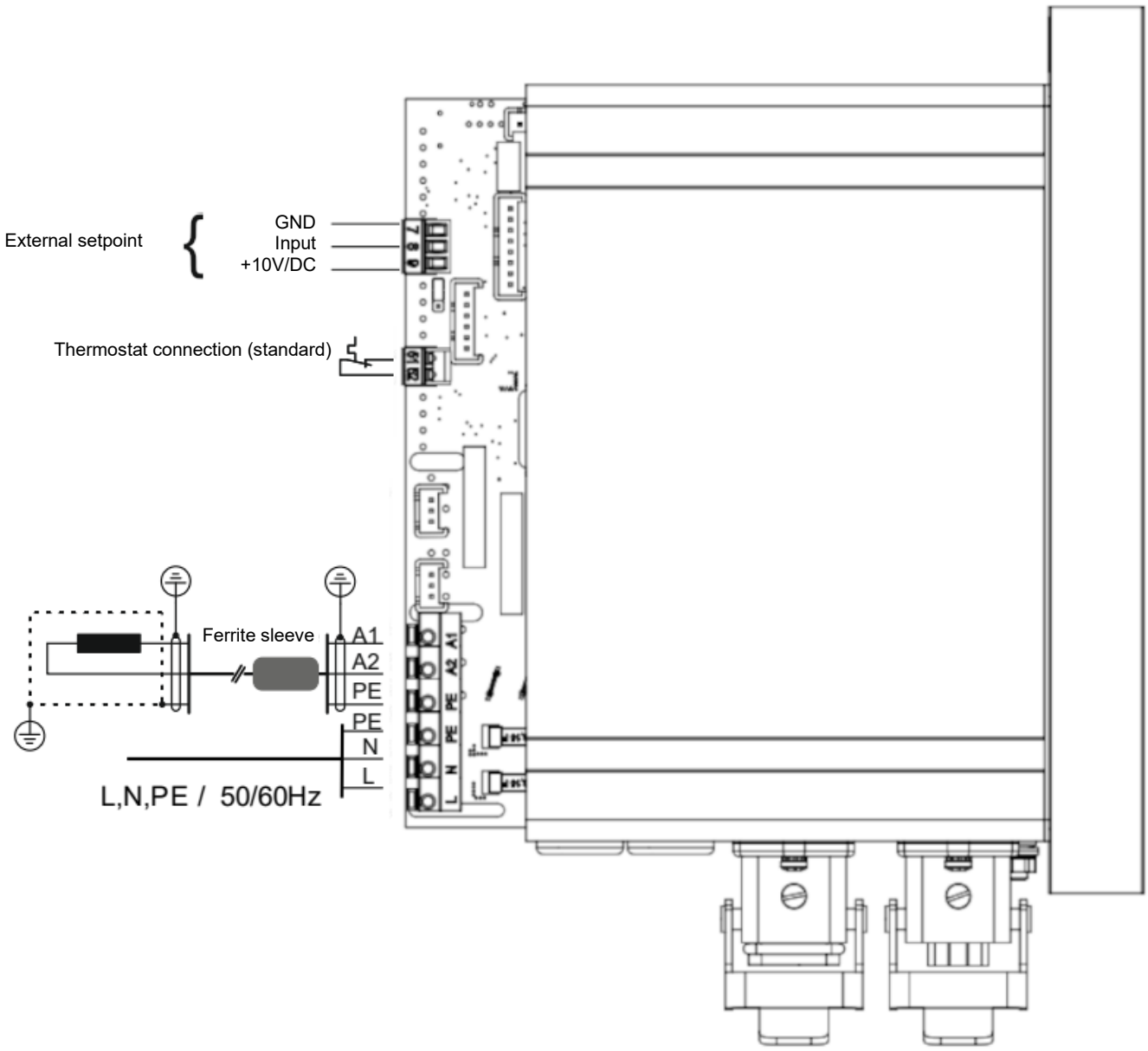
X1 Output to feeder
1 = A1
2 = A2
3 = nc
4 = nc
5 = PE



Male connectors X4, X5, X6, X7, X40 are 4/5-pin M12x1 connectors The connectors installed in the controller are female.
Attention! Do not fed a 24 V supply voltage into the females.

To comply with EMC requirements, a shielded output cable must be routed to the feeder, and fed through the enclosed Ferrite sleeve.

Enclosed version (IP54, 6A)
Internal connections



Attention!
Any work on electrical equipment of the machine/system shall be carried out exclusively by a professional electrician, or by instructed persons working under the direction and supervision of a professional electrician, according to electrotechnical rules.

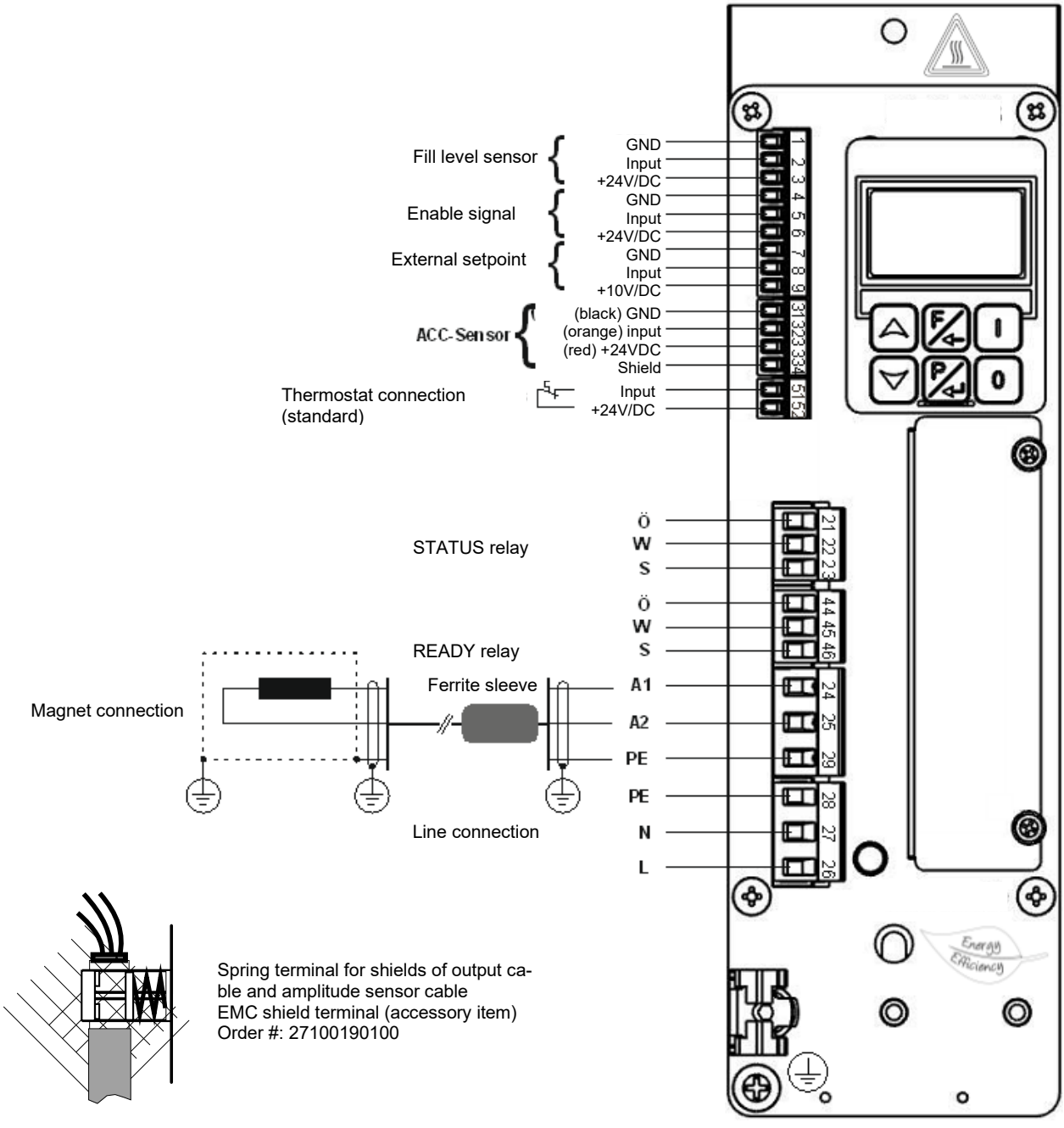
If an external setpoint or a thermostat are to be used you must open the device.
Be sure to observe the safety instructions mentioned above.
Carefully unscrew the front module, remove a blanking plug and replace it with a suitable cable gland. Insert the cable and connect it to the terminal. Screw the front module back into place. Make sure that the required protection rating (IP54) is preserved.

Connection for external setpoint:
Terminal 7: GND
Terminal 8: Input (0/2-10V, 0/4-20mA)
Terminal 9: +10VDC

Connection of thermostat:
(floating contact)
Terminal 51
Terminal 52

Cabinet-style version (IP20, 6A)

Connecting terminals

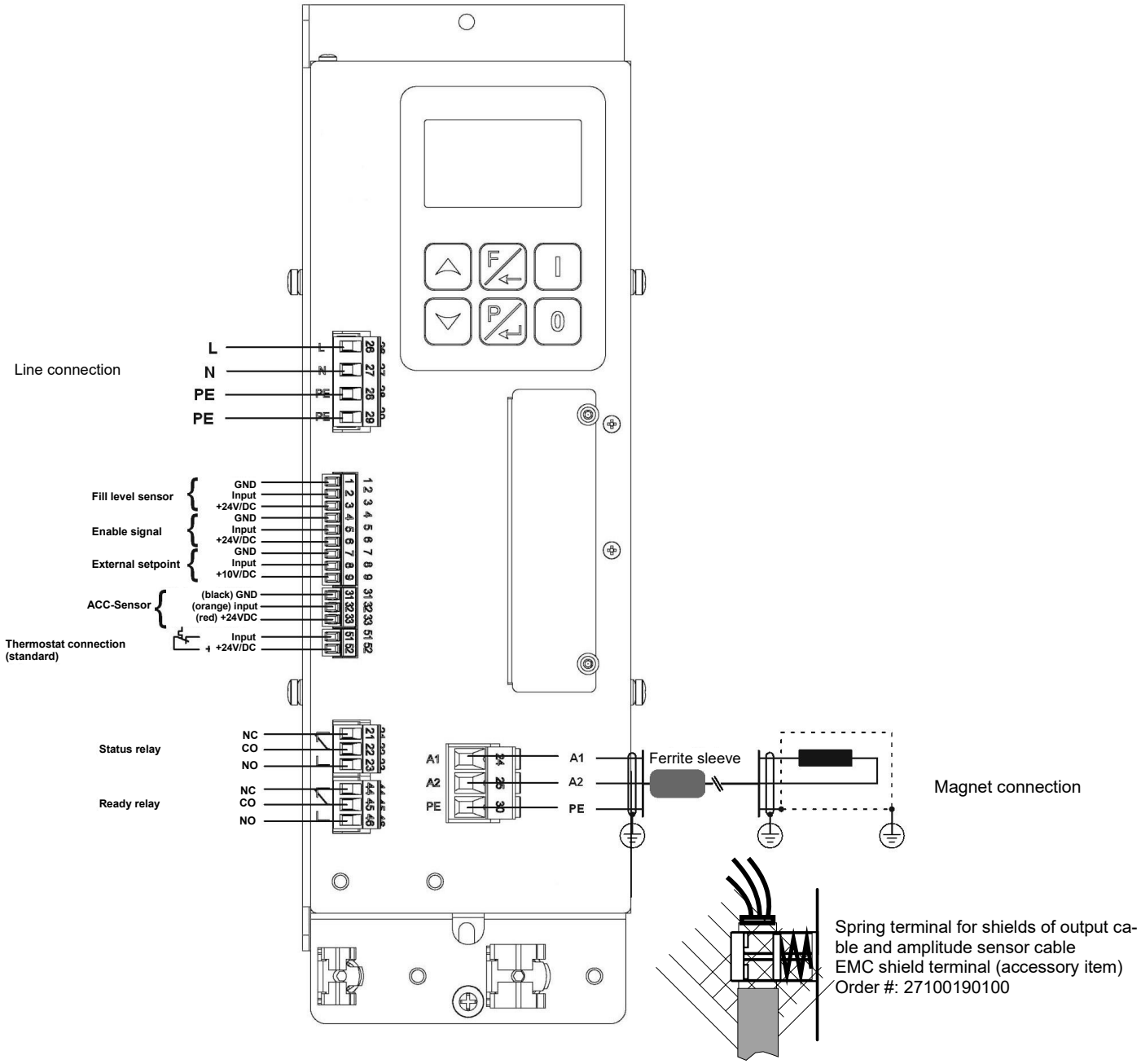


Spring terminal for shields of output cable and amplitude sensor cable
EMC shield terminal (accessory item)
Order #: 27100190100

To comply with EMC requirements, a shielded output cable must be routed to the feeder, and fed through the enclosed Ferrite sleeve.

Cabinet-style version (IP20, 16A)

Connecting terminals



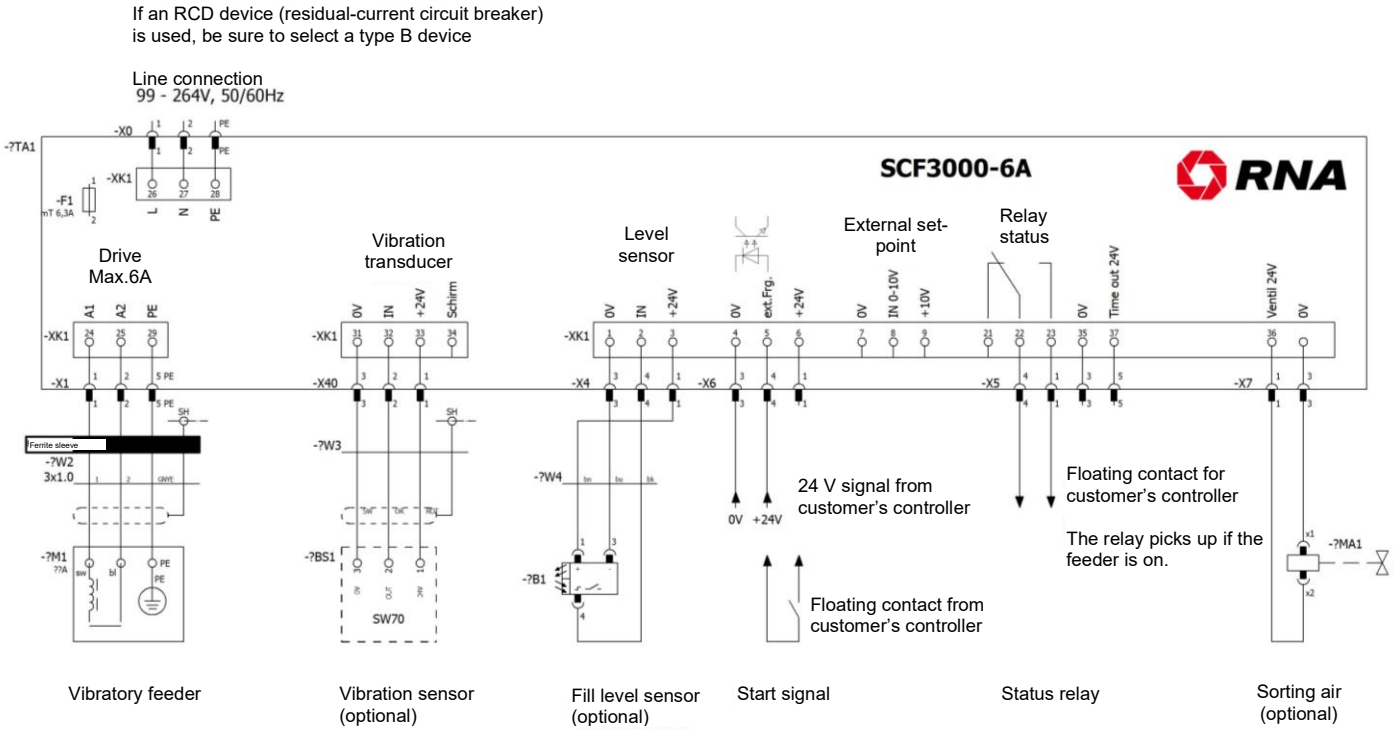
To comply with EMC requirements, a shielded output cable must be routed to the feeder, and fed through the enclosed Ferrite sleeve.

12.2. Connection of vibration amplitude sensor:

Controller	Function	Vibration amplitude sensor cable colour	Vibration amplitude sensor with male M12 connector	With standard Extension cable
Terminal 31	GND	Black	Pin 3	Blue
Terminal 32	Signal	Orange	Pin 2	White
Terminal 33	+24VDC	Red	Pin 1	Brown
Terminal 34	Shield	Shield	Shield	Shield

12.3. Connecting diagrams for controllers

Enclosed version (IP54, 6A)

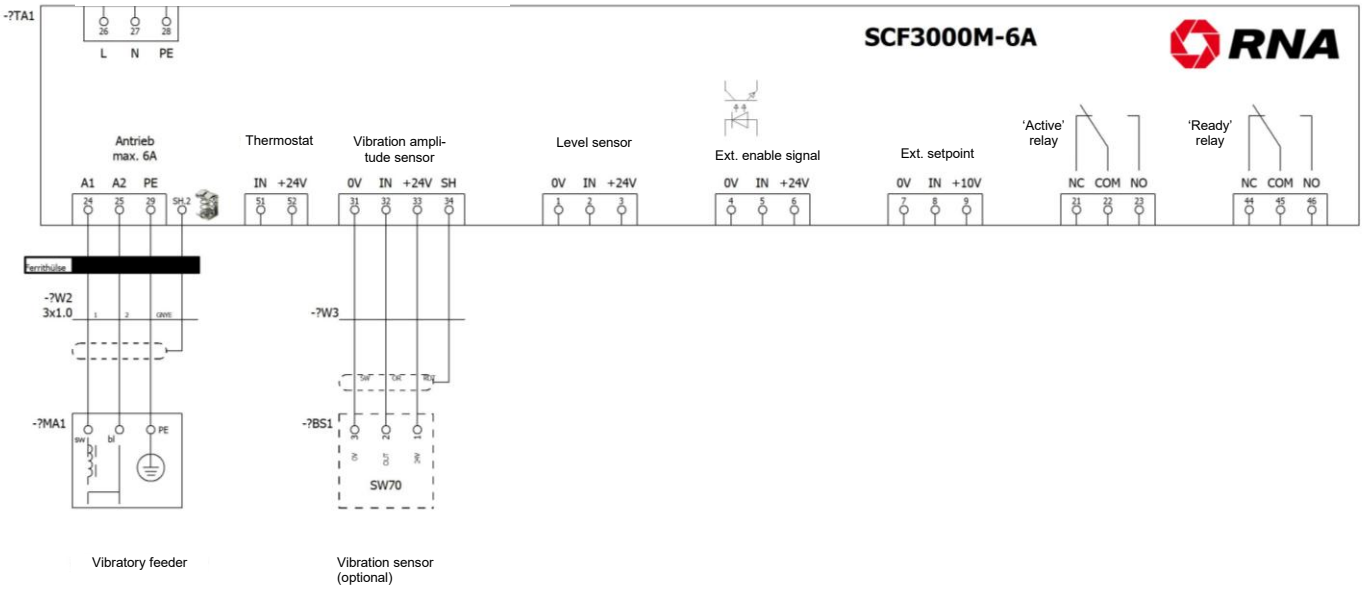


Attention! Do not fed a 24 V supply voltage into the females.

Cabinet-style version (IP20, 6A)

If an RCD device (residual-current circuit breaker) is used, be sure to select a type B device

Line connection



Vibratory feeder

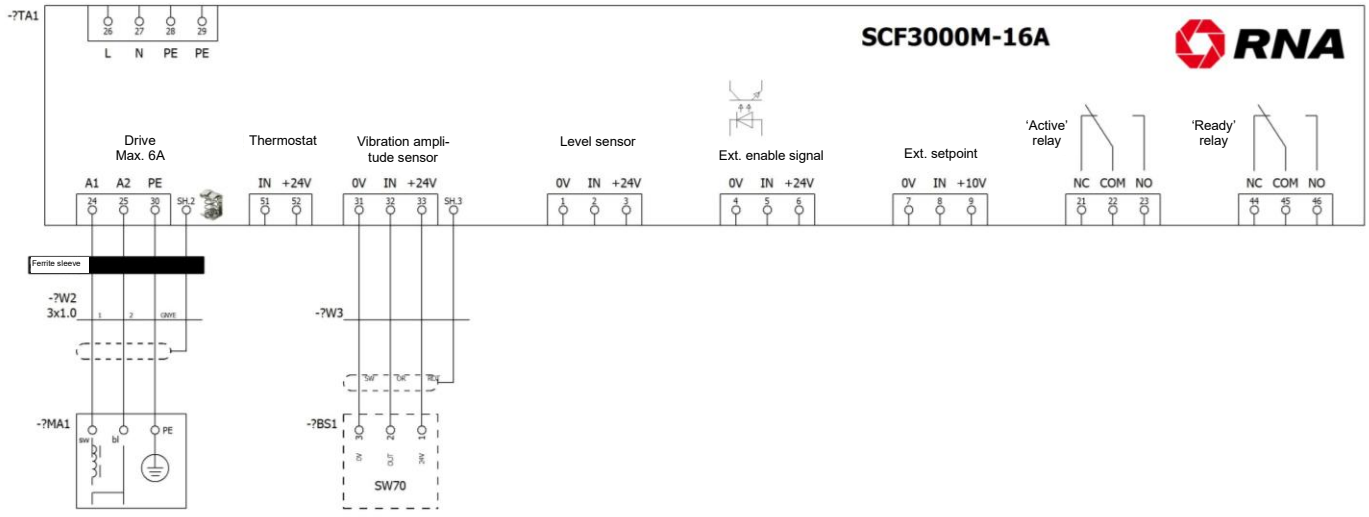
Vibration sensor (optional)

Attention! Do not fed a 24 V supply voltage.

Cabinet-style version IP20, 16A

Bei Einsatz eines RCD Schalters (FI Schutzschalter), unbedingt Typ B einsetzen.

Netzanschluss
99 - 264V, 50/60Hz



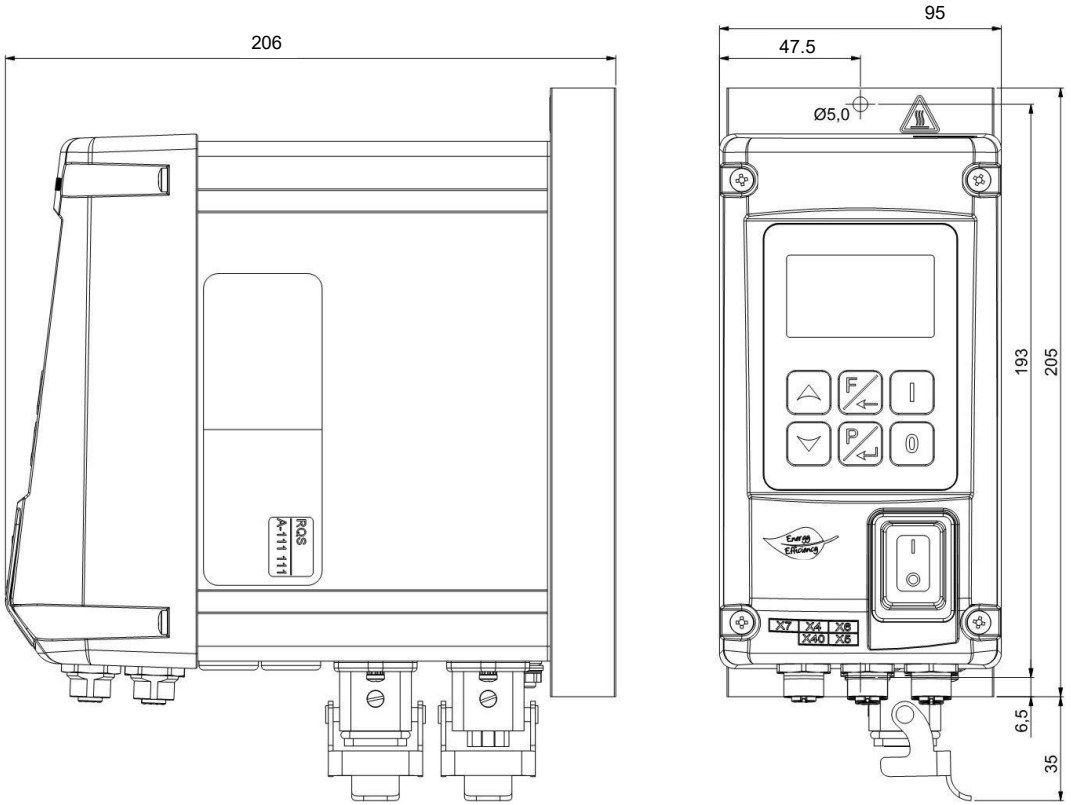
Vibratory feeder

Vibration sensor (optional)

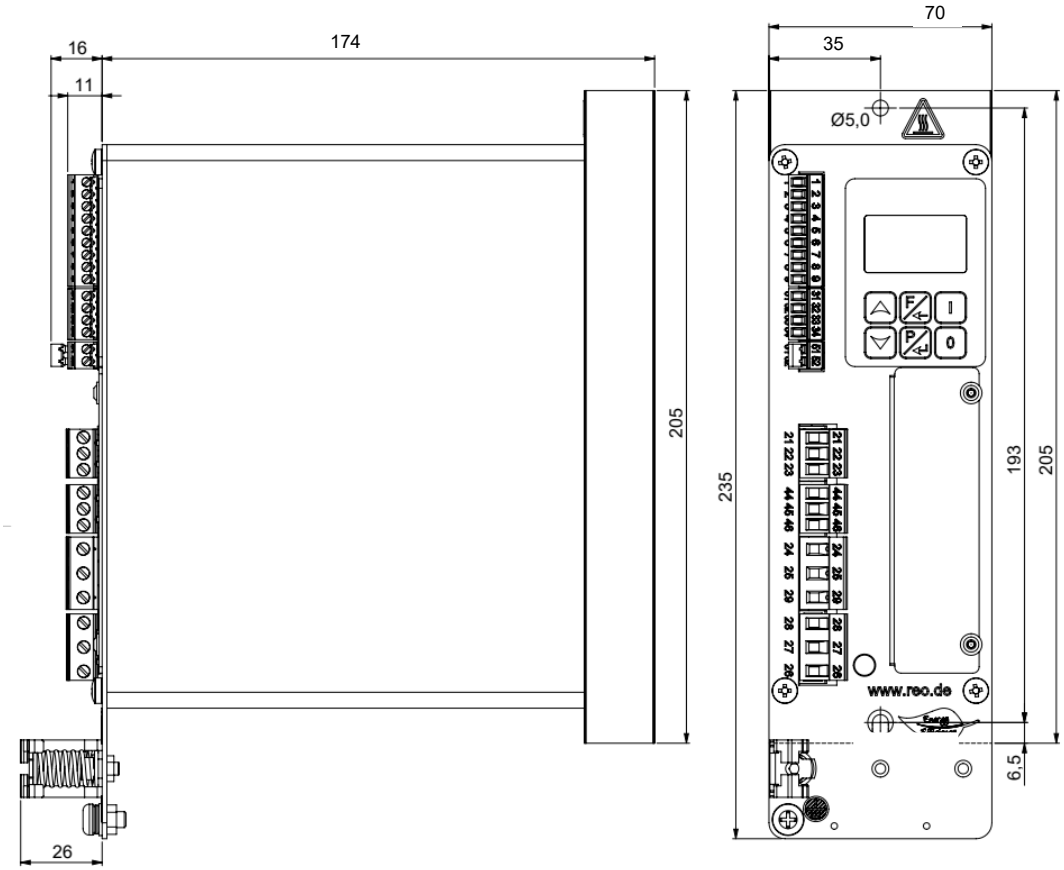
13. Controller dimensions

Following applies to all device variants:
Mounting clearances measured from heat sink: 100mm ea. at top and bottom, 10mm each on left and right

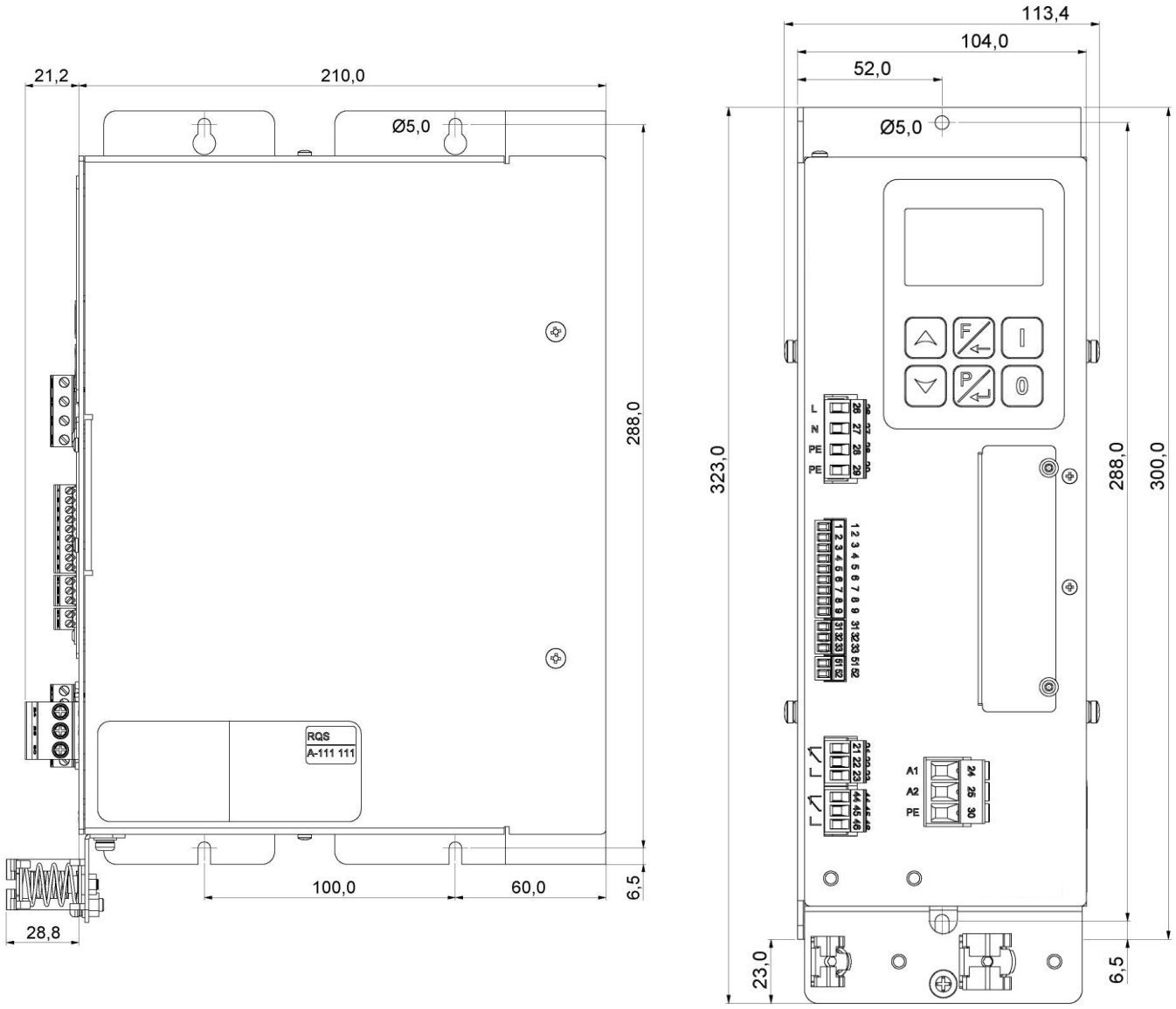
13.1. Dimensions of IP54 6A enclosed version



13.2. Dimensions of IP20 6A cabinet-style version



13.3. Dimensions of IP20 16A cabinet-style version



14. Annex - Service

Attention!
The settings in the Service parameters described here must only be made by trained specialists as they influence the function and limit values of the feeders.

The service parameters cannot be accessed directly in the normal menu structure, but have to be enabled via an additional key code.

14.1. Service Parameters

The service parameters must be enabled in the Service menu. Enter key code '127' to unhide the menu item 'Service ON'. After activation of this parameter, following service parameters are shown in the Limit Values menu.

- **Limit Current** - Protection of the magnets against overcurrent (percentage value of the max. current)
  The output current limit sets the maximum current permitted by the magnets installed. The output current is limited to this value.
  Factory setting: 100%.

- **El. Tripping**– When this limit is exceeded the current will not be limited but the output will be disabled.
  Factory setting: switched off.

- **Min Frequency, Max Frequency -** Protection against system detuning. Setting of the lower and upper frequency limit. Maximum ratio 1:4. The vibrating frequency range determines the adjustable frequency range for the user.
  Factory setting:
  Min freq = 35.0Hz
  Max freq = 140Hz
  Recommended frequency limit: Vibrating frequency of conveyor +/-20%

- **Umax -** Output voltage limitation (percentage value of 230V)
  The output voltage limitation enables you to operate magnets having a working voltage of 115V, for example, on a 230V mains also (Umax = 50%).
  The maximum output voltage also depends on the 'Max' parameter setting in the 'Feeder' menu.
  Factory setting: Umax = 100%, max. 90%, i.e. maximum output voltage of approx. 205V.
  Should you change be sure to verify the load current and load voltage with suitable measuring instruments.
  See also the measurement of output voltage and output current described in chapter 'Commissioning'.

15. Attachment 'Commissioning of Closed-Loop Operation with Amplitude Sensor'

Before commissioning closed-loop operation a basic set-up of the vibratory drive must be performed.
The basic set-up procedure is described in the operating instructions of the vibratory feeder.
Commissioning in manual mode must have been completed. See chapter 'Commissioning of manual mode' in this manual.

15.1. For what feeders is closed-loop operation suitable?

- In the majority of cases it won't be necessary to equip a vibratory feeder with closed-loop amplitude control. With heavy parts, high feed rates etc., it may however be necessary to use amplitude control to achieve uniform feed rates.
- Closed-loop operation is used mostly with linear feeders and hoppers.
  Be advised, however, that small linear feeders are not suited for operation with an amplitude sensor.
- Suitable linear feeder types are SLL400, SLL800, SLL804, SLF1000/1020/1040, SLK1, SLK-N6, SLK12, SLC500, SLA400.
- Also hoppers of types BV and BVL, which are based on linear feeders SLL400, SLL804 and SLF1000.

- In the same way, small bowl feeders are not suited for operation with amplitude sensors either. Only with SRC-N400 and larger feeders may it be useful to operate the feeder with closed-lop control, depending on the application on hand.
- However, correct installation of the amplitude sensor being difficult on most bowl feeders, we recommend to pair these feeders with ESR2500/ESR2800 controllers. This controller is capable of maintaining a constant running speed following a calibration run, even without an amplitude sensor.

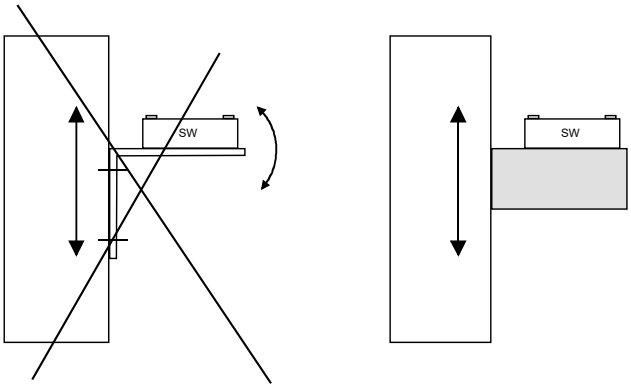
See also the tables in chapter **Data of most common vibratory feeders for closed-loop control with amplitude sensor**.

15.2. Notices on closed-loop control

- With closed-loop control, the vibratory feeder operates at its resonance frequency. In practice, however, the resonance frequency range cannot be used without acceleration feedback and closed-loop control of the drive frequency. As the resonance frequency depends on such factors as loading, temperature etc. the feeder would not respond properly to load changes and become uncontrollable.
- Therefore, closed-loop operation with SCF3000 controllers requires an amplitude sensor, such as SW70 or SW68, mounted on the vibratory feeder.
- In closed-loop operation with sensor feedback, **all** vibrations detected by the sensor are processed in the control loop. Extraneous vibrations that may be caused, for example, by adjacent machinery, unstable mounting of the feeder or poor installation of the amplitude sensor can cause incorrect control responses. Especially during the frequency search, no external influences must act on the feeder.
- **Resonance frequencies:** Based on the design of the spring-mass system of the feeders, the system can enter resonance on several vibrating frequencies. The additional resonance points lie on a multiple of the desired frequency. In critical cases, the automatic frequency search will then not be able to detect the desirable vibrating frequency. Here it can be helpful to limit the frequency search range to the feeder vibrating frequency +/- 20% (also refer to the operating instructions, attachment ‘Service Parameters’.

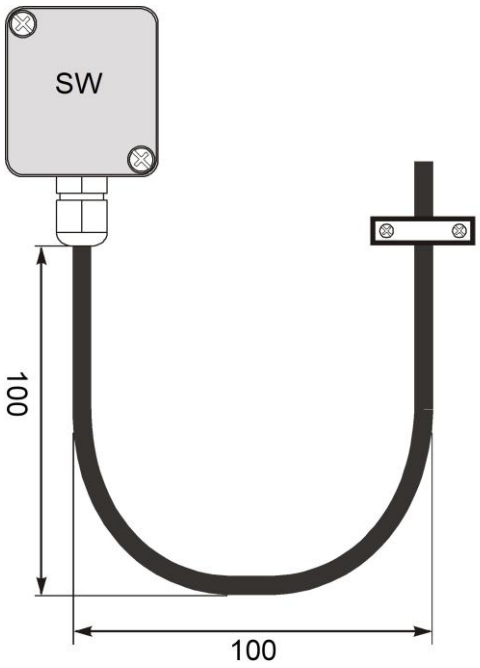
15.3. Mounting of the amplitude sensor

The amplitude sensor serves to provide feeder motion and acceleration feedback to the controller. It is imperative, therefore, that no additional, parasitic vibrations resulting from inadequate installation of the sensor be measured.



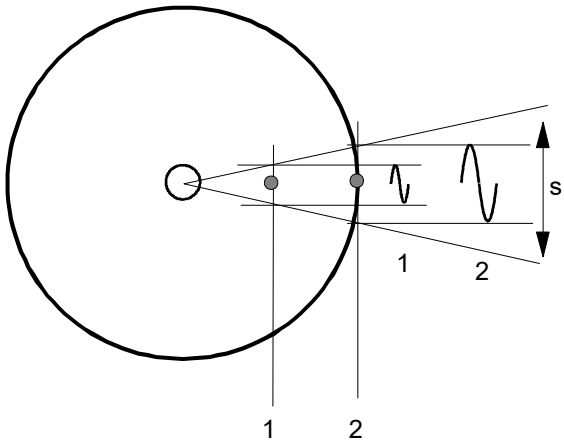
The sensor should be mounted in the direction of vibration, ideally at the same angle as the feeder springs, on a massive support that won’t generate any natural vibrations.

The amplitude sensor cable must be fixed with a cable clamp to prevent damage to the cable.



Cable clamp

Example: Bowl feeder



With bowl feeders it makes sense to install the sensor as far on the outer diameter as possible in order to cover as large as possible an amplitude.

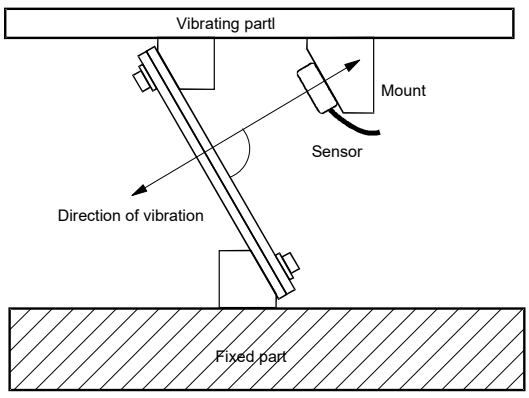
If the sensor signal is too small, the control range of the set-point will be limited too much.

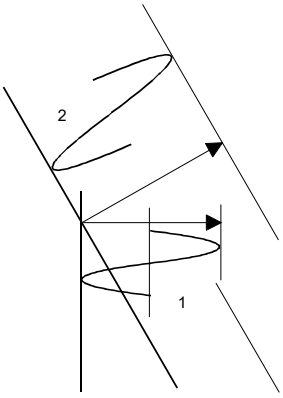
S = amplitude

Mounting location 1 = small amplitude
Mounting location 2 = large amplitude

With closed-loop control, the output signal level directly determines the maximum amplitude of the feeder.

Example: Linear feeder





1. Small amplitude with vertical mounting

2. Larger amplitude when mounted at the same angle as the springs.

The controller and the sensor mounted on the feeder form a closed control loop, where the signal supplied by the sensor has a decisive influence on the setpoint output range. This means that the controller controls the feeder in such a manner that the actual value (feed rate or vibrating intensity) corresponds to the

setpoint value (ideally: 100 % setpoint = 100 % actual). As the actual value depends on the feeder (vibrating frequency, acceleration, amplitude), however, and also on the mounting location of the sensor, you will usually need to adjust the output range.
This adjustment is made with the parameter ‘Max’ in the ‘Feeder’ menu. The value set here serves to adjust the measured sensor signal. In most cases, you must enter a value of less than 100 so that the setpoint control range extends up to 100 %, or is at least as large as possible.
If no satisfactory adjustment can be achieved, move the amplitude sensor to a location where the amplitude is larger (see example of bowl feeder).
The importance of adjusting this value is shown for example by the response time of the controller. A poorly adjusted actual value signal may for example result in a very slow run-up when the feeder is started.

15.4. Relation between acceleration and amplitude

The sensor measures the instantaneous acceleration of the feeder. This translates to a sinusoidal output voltage of the sensor. The acceleration rises with increasing vibrating frequency. As a consequence, the sensor output signal at high frequencies and small amplitude may perfectly well be higher than with small frequencies and larger amplitudes.

Acceleration

$a = \omega^2 \, s$ wher $\omega = 2 \pi f$

In practice, acceleration is placed in relation to the acceleration of gravity, and the useful amplitude is measured in mm. This gives the following rule of thumb:

$$a[g] = \frac{2^2 \, \pi^2 \, f^2[Hz]^2 \, s_n[mm]}{9{,}81 \qquad 2 \cdot 10^3} = \frac{f^2[Hz]^2 \, s_n[mm]}{497}$$

a[g] = acceleration (relative to the acceleration of gravity 9.81 m/s^2)
S_n[mm] = useful amplitude

In a practical example, with 497 ~ 500, this would give:
1.)
Vibrating frequency 50 Hz, amplitude 3 mm

$$a = \frac{50^2 \cdot 3}{\approx 500} = 15 g$$

or
2.)
Vibrating frequency 33 Hz, amplitude 5 mm

$$a = \frac{33^2 \cdot 5}{\approx 500} = 10{,}89 g$$

With a sensor output voltage of 0.3 V/g, the sensor, at a peak acceleration of 15 g (example 1), generates a peak voltage of 4.5V, which corresponds to an effective value of 3.18V.
Example 1: => 15 g => 4.5 V => 3.18 Veff.
Example 2: => 11 g => 3.3 V => 2.33 Veff.

Due to the significantly different acceleration values of the various feeders, there may therefore big differences in the feedback signals which require an adjustment of the controller to the maximum value.

15.5. Data of RNA's most common vibratory feeders for amplitude-sensor controlled operation

Attention:
A precondition for constant and stable performance is an even weight distribution on the linear rail respectively in the feeder bowl.
A well balanced spring package configuration is described in detail in the corresponding operating instructions.

RNA feeders are fitted with differently coloured magnets and connecting cables for easy distinction between vibrating frequencies.

Magnet colour	Cable colour Magnet connection	Vibrating frequency for operation with line frequency	Vibrating frequency for operation with variable frequency
Red	Black	50Hz	47 –56 Hz
Black	Grey	100Hz	97 – 106Hz

Vibratory feeders, due to their mechanical design, can only be protected against damage by operating them in a proper way.
This is why the electrical operating conditions must be adapted to the vibrating system. The following tables show the variable safe operating ranges for the complete RNA product range.

Table 3

Linear feeder motor type	Max. load current [A_{eff}]	Max. air gap at magnet [mm]	Frequency range	Magnet body colour
SLL 400	0.6	1	97...106 Hz	black
SLL 800	1.4	3	47…56 Hz	red
SLL 804 <1600	1.4	3	47…56 Hz	red
SLL 804 ≥1600	2.8	3	47…56 Hz	red
SLF 1000-1000	2.8	2.5	47…56 Hz	red
SLF 1000-1500	5.6	2.5	47…56 Hz	red
GL 01	0.6	1.5	97...106 Hz	black
GL 1	1.1	1	97...106 Hz	black
SLK - N 6	1.4	2.5	47…56 Hz	red
SLK - N 6 G	1.4	2.5	47…56 Hz	red

Table 3: RNA linear feeders

Table 4

Bowl feeder Motor type	Max. load current [A_{eff}]	Max. air gap on magnet [mm]	Frequency range	Magnet body colour
SRC - N 400 - 1	3.8	2.8	47…56 Hz	red
SRC - N 400 - 2	4.3	1.2	97...106 Hz	black
SRHL - 400 - 1	5.7	2.8	47…56 Hz	red
SRHL - 400 - 2	5.3	1.5	97...106 Hz	black
SRC - N 630 - 1	5	2.8	47…56 Hz	red
SRC - N 800 - 1	8.5	3.0	47…56 Hz	red

Table 2: RNA bowl feeders

If the excitation frequency deviates more than -3Hz / +6Hz from the oscillation frequency specified in the operating instructions (50Hz or 100Hz), springs must be installed or removed.

15.6. Automatic frequency search and control-loop operation

Preconditions:

- The basic set-up of the vibratory drive is completed.
- Commissioning in manual operation is completed.
- The amplitude sensor is correctly installed and connected.
- There must be no extraneous vibrations from other machinery etc.
- The feeder must be empty.

Commissioning on the example of a feeder with a vibrating frequency of 50 Hz.

	Action	**Settings menu**	**Parameters**	**Value**	**Note**
1	Set setpoint value to 0	Power	Feeder	0%	Feeder stops
2	Activate Service mode	Service	Key	127	Enter key code 127 The additional menu item Service ON appears.
3		Service	Service ON	On ☑	Check the box Activate Service mode
4	Limit the output frequency	Limit values	Min.Freq	35Hz	Min. frequency for frequency search
5		Limit values	Max.Freq	70Hz	Max. frequency for frequency search
6	Deactivate Service Mode	Service	Key	127	Enter key code 127 The additional menu item Service ON appears.
7		Service	Service ON	Off ☐	Uncheck the box Deactivate Service Mode
8	Turn vibration amplitude control ON	Feeder	ACC.controller	On ☑	Check the box More parameters appear. Do not change 'Prp.Gain' and 'Integral'.
9	Frequency control Starting	Feeder	Auto.freq.	On ☑	Check the box
10	Switch feeder ON				Press the green Start key
11	Increase setpoint slowly	Power	Feeder	>0	As soon as the acceleration of the feeder generates a sufficiently large sensor signal, the inverter will automatically start frequency search and control. The inverter automatically saves the last frequency found.
12	Set the desired vibration amplitude	Power	Feeder	80%	As soon as the inverter runs stably at the resonance frequency found, you can set the desired vibration amplitude.

When setting the frequency limits for the resonance frequency search, be advised that the minimum and maximum frequency limits exclude the multiples of the vibrating frequency.
For reliable operation we recommend that the frequency range be limited as much as possible.
Typical example:
Vibrating frequency 50Hz: Min.freq = 35Hz Max.freq = 70Hz
Vibrating frequency 100Hz: Min.freq = 80Hz Max.freq = 120Hz

15.7. Optimizing the controller, if necessary

In most cases you will achieve a satisfactory feeding behaviour with the standard parameters. Sometimes, however, it will be necessary to optimize the control response.

If the limits of the control range are reached, you can adjust the output range.

1) From a given setpoint onward, e.g. 70%, the speed will not increase any further.

   The maximum output voltage is already reached at 70%. The symbol (100) shown in the display. The signal from the vibration amplitude sensor is too small.

   Remedy: - In the ‘Feeder’ menu, set the parameter ‘Max’ to a lower value.
   - Mount the vibration amplitude sensor at a different location where the vibration amplitude is higher.

2) With a setpoint of 100%, the maximum possible speed is not reached.
   The max. output voltage is not reached even though the setpoint is 100%.
   The signal from the vibration amplitude sensor is too large.
   Remedy: - In the ‘Feeder’ menu, set the parameter ‘Max’ to a higher value.
   - Mount the vibration amplitude sensor at a different location where the vibration amplitude is less.

Optimizing the control loop: With pumping feeders or insufficient corrections in case of load variations.
The response time of the control loop can be influenced in the ‘Feeder’ menu via the parameters ‘Prp.Gain’ (proportional component resp. loop gain) and ‘Integral’ (integral component) to adapt it to the response time of the feeding system.

Feed rate fluctuates.
In the ‘Conveyor’ menu, reduce the value for ‘Prp.Gain’ until the fluctuation diminishes.

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